Modeling of local deposition and long-range transport for the Pacific Basin

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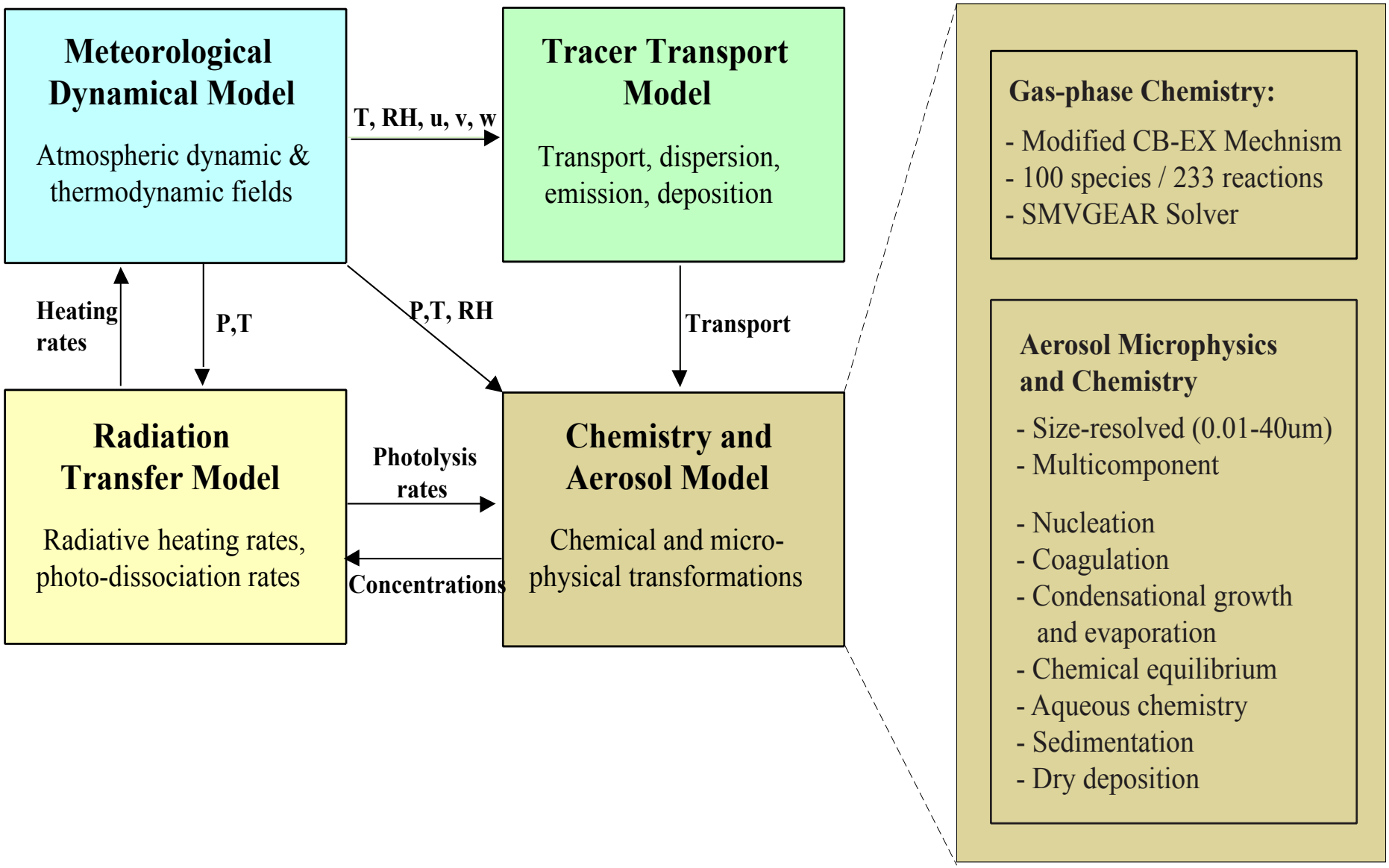
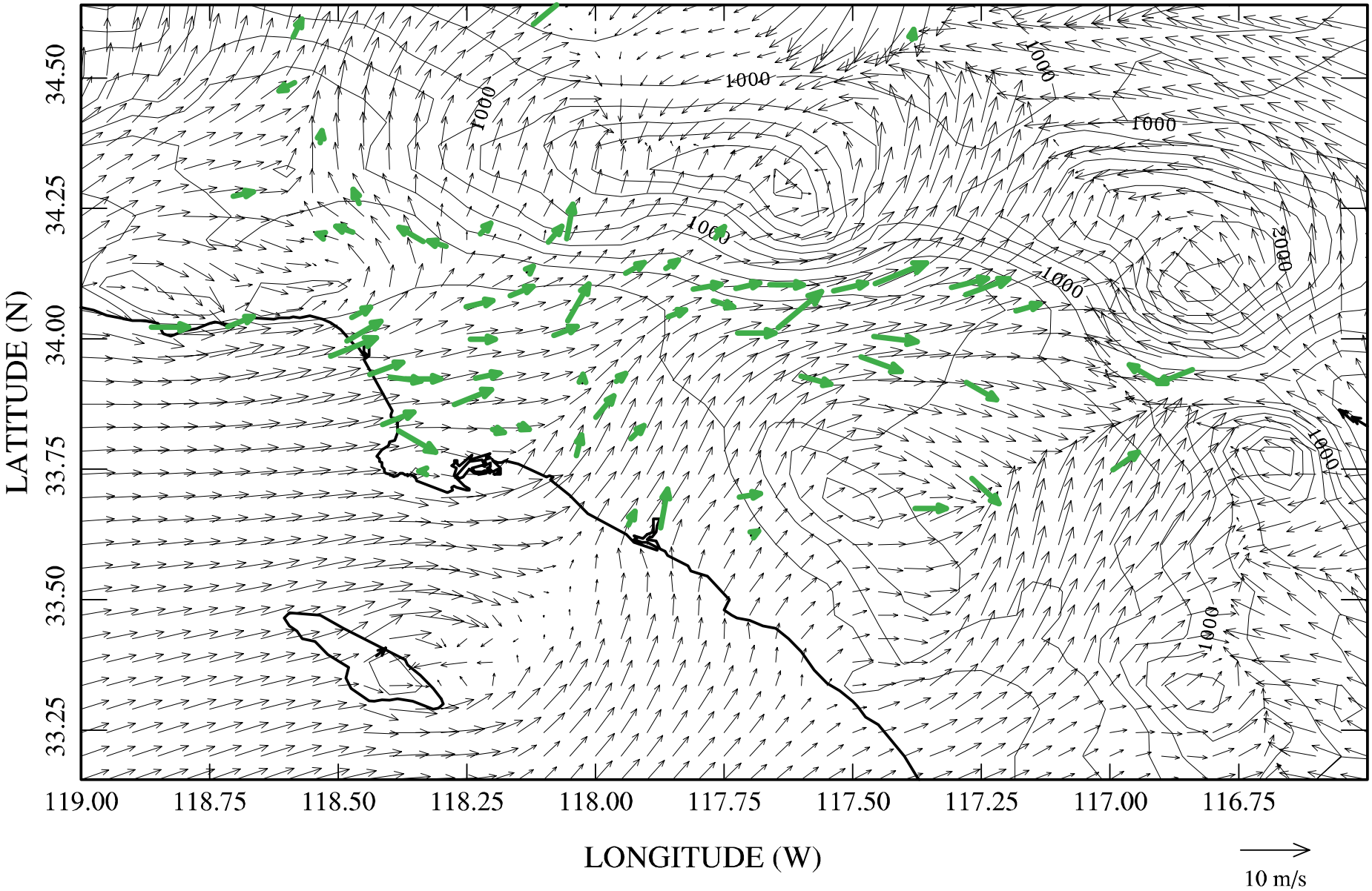
Outline

- Deposition of nitrate and trace metals in the LA basin
- Pollution transport from urban to regional scale
- Simulations of dispersion during Asia dust event
- Conclusion and future work

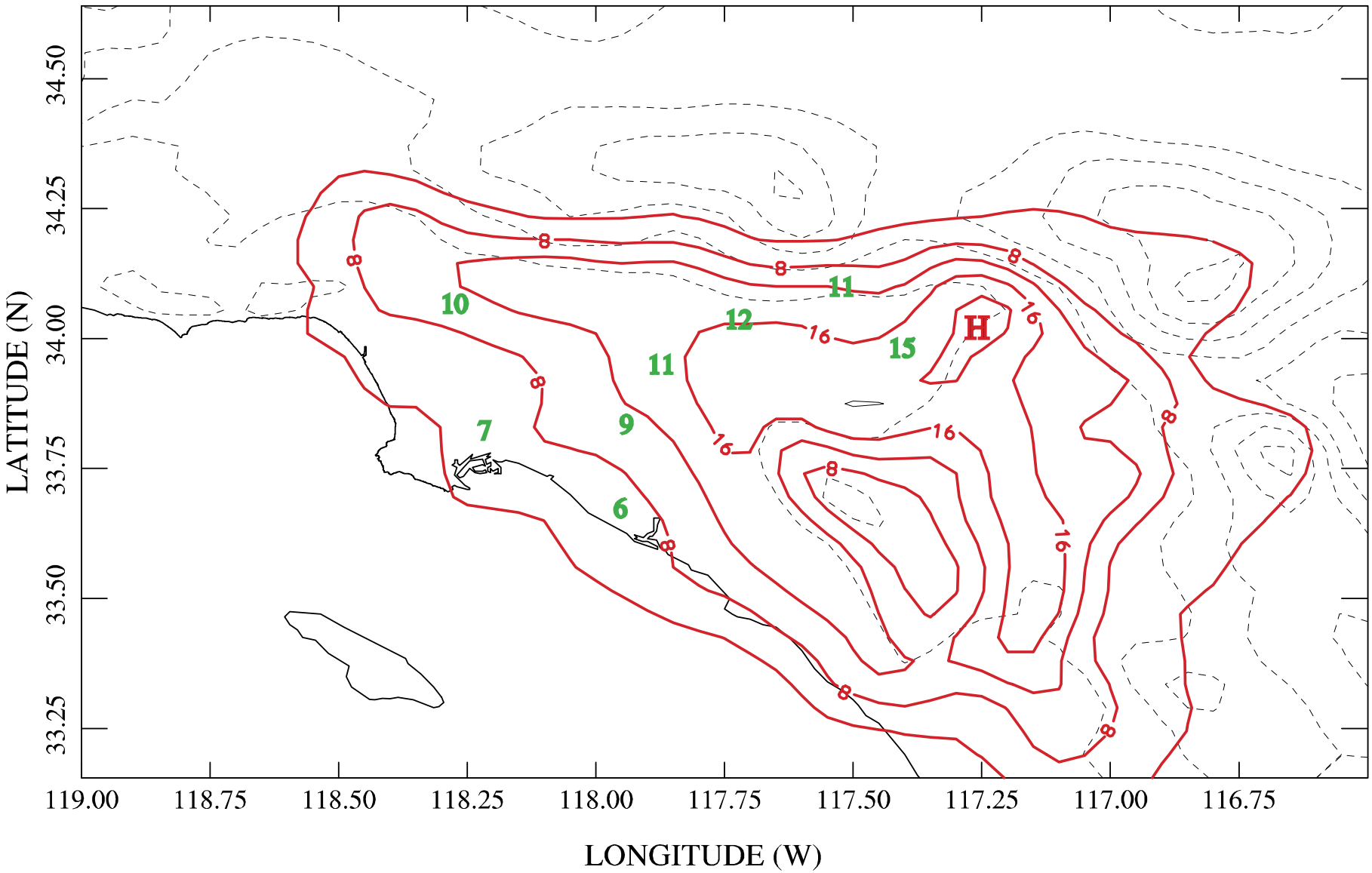
SMOG Air Pollution Modeling System



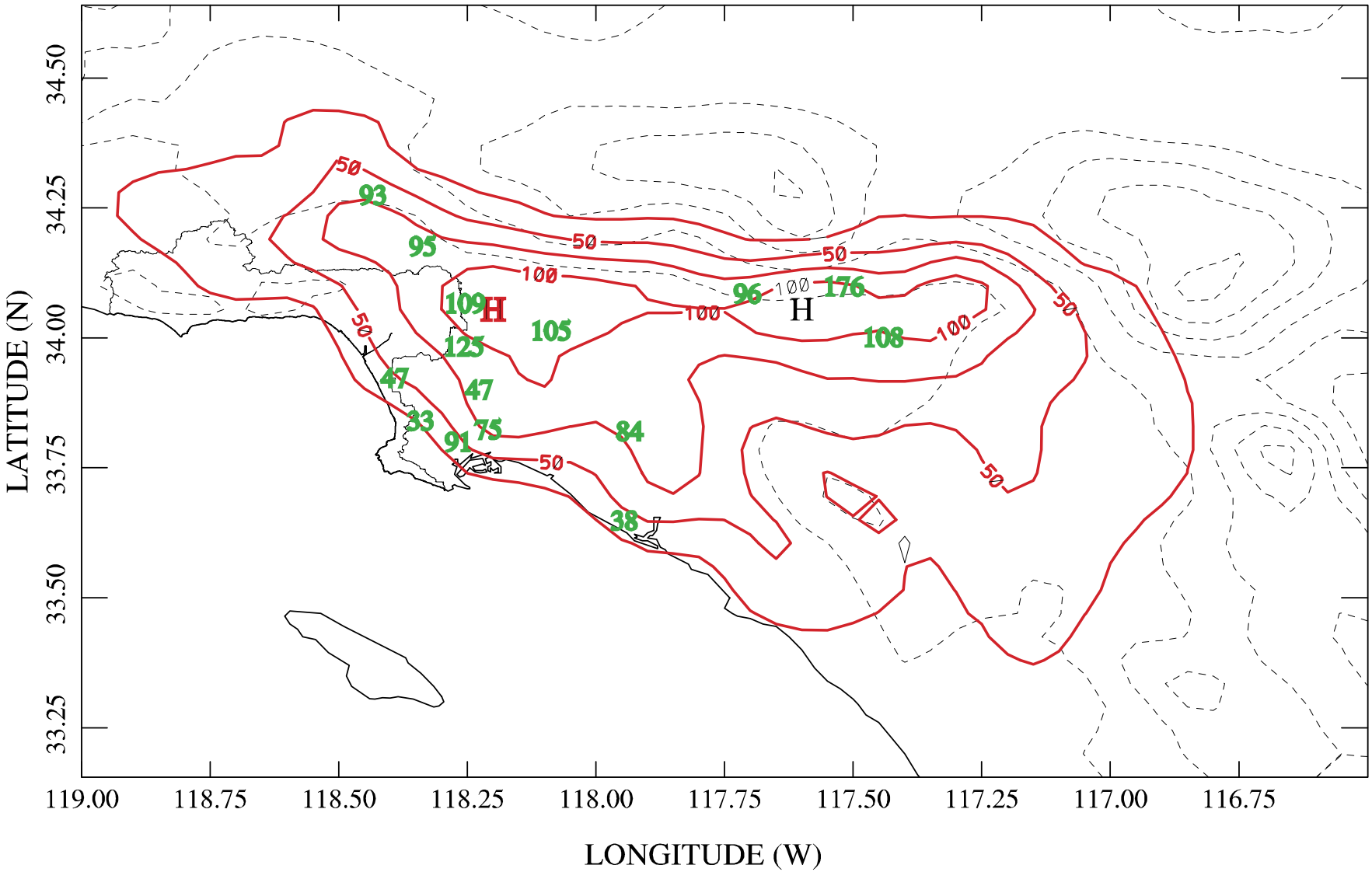
Simulated and Observed Surface Winds in the LA Basin



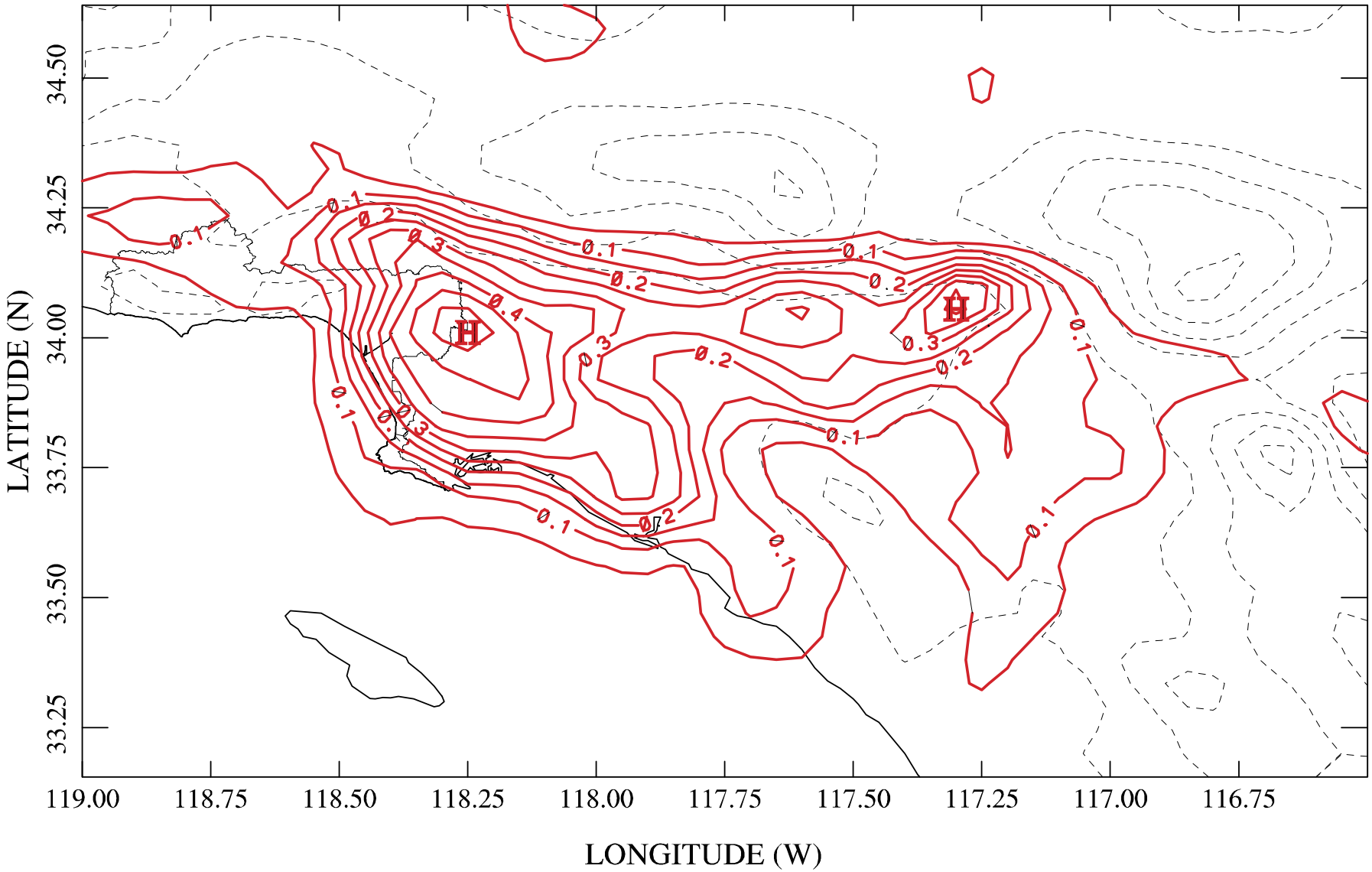
Simulated and Observed PM_{10} Nitrate Concentration



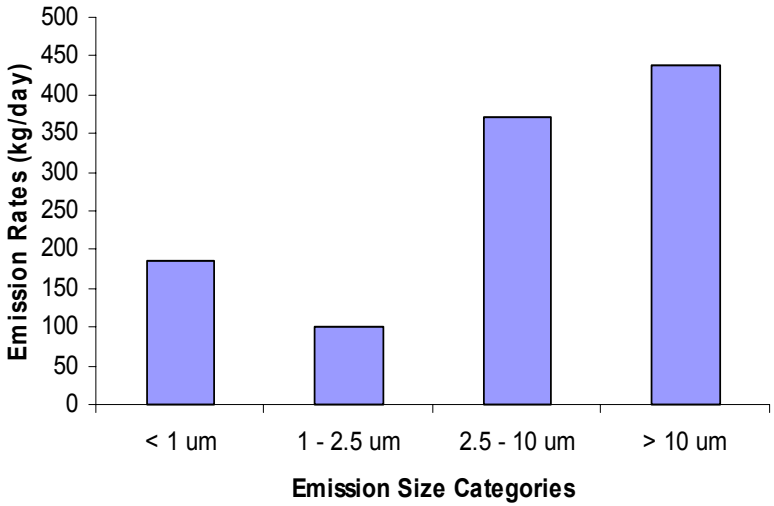
Modeled and Measured Zn Total Mass Concentrations

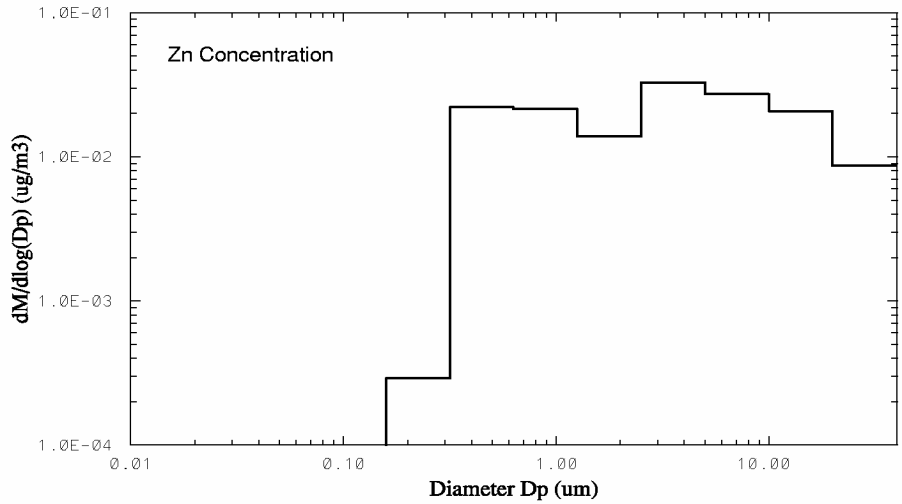


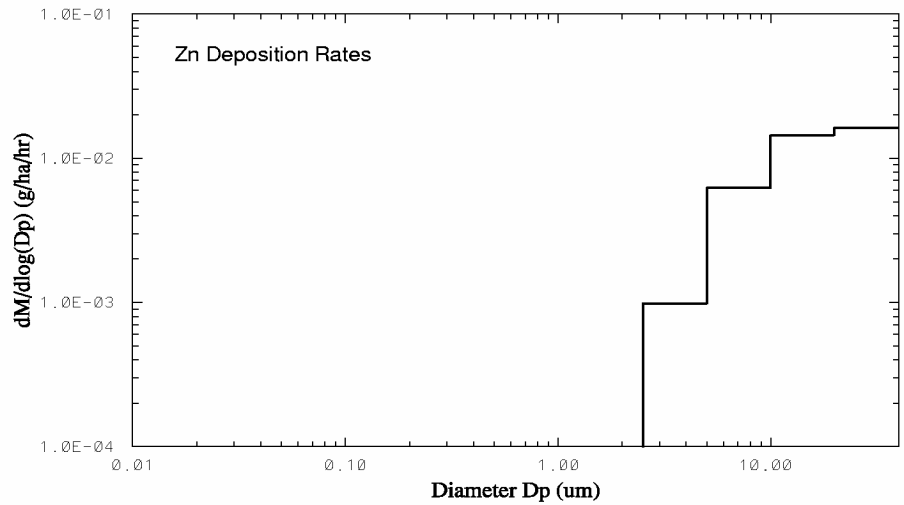
Modeled Zn Deposition Rates in the LA basin



Zn mass size distributions in emissions, airborne concentration, and deposited particles



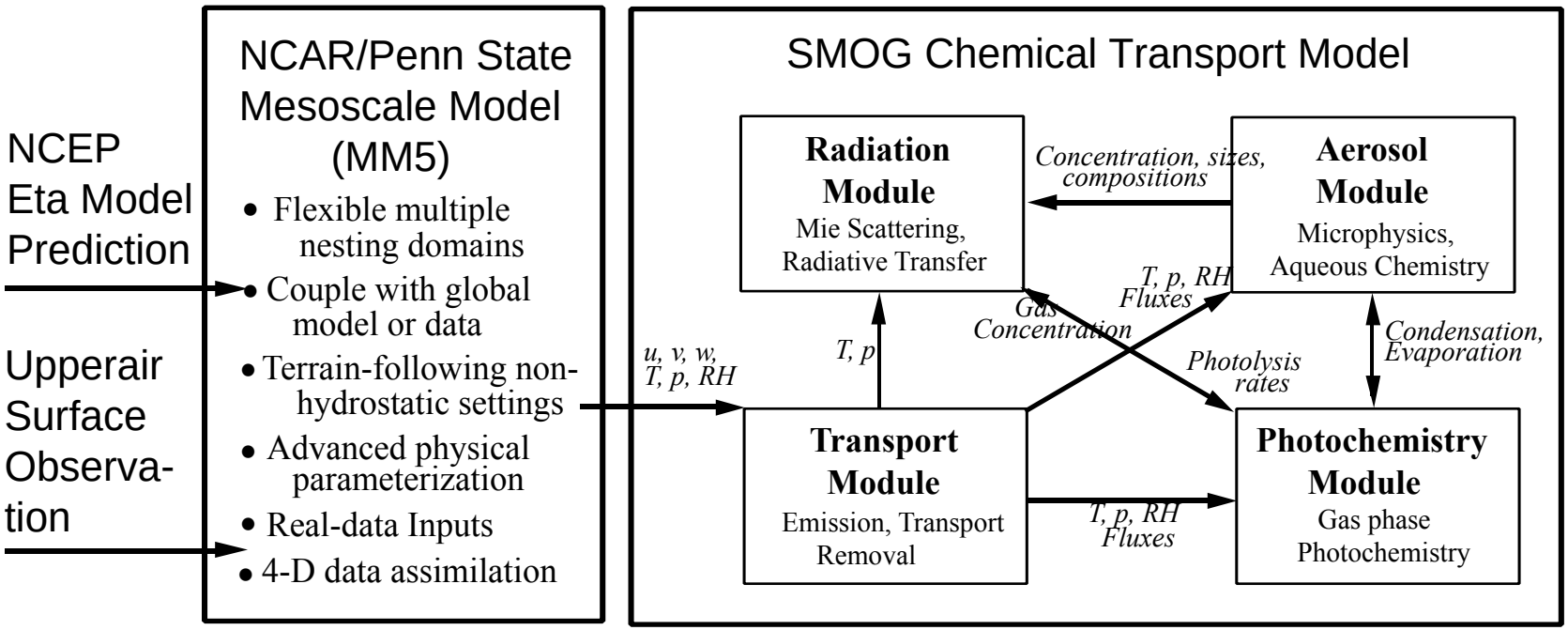


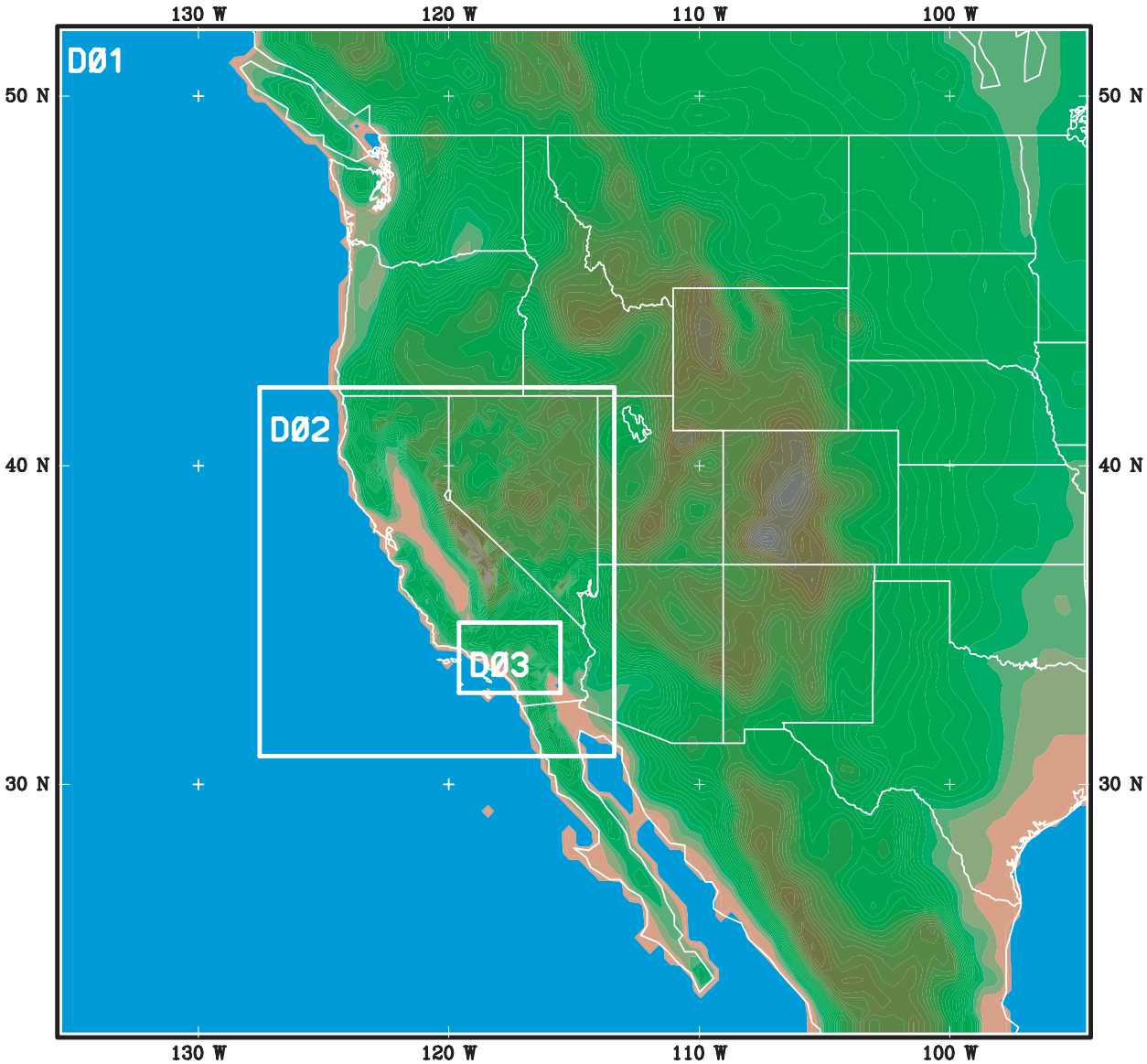


Mass budgets of emissions for local deposition and long-range transport (for a summer day in Los Angeles)

	Emissions (tons/day)	Local Deposition (%)	Transport (%)
CO	7936	3%	97%
O_3	2415 *(net production)*	15%	85%
NO_y Organic/ aerosol nitrates	1044 *(NO2)*	26%	74%
Al	58.6	42%	58%
Fe	38.8	44%	56%
Mn	0.78	43%	57%
As	0.027	26%	74%
Cd	0.022	28%	72%
Cr	0.23	35%	65%
Cu	0.12	42%	58%
Pb	0.64	43%	57%
Ni	0.092	36%	64%
Zn	0.94	44%	56%

MM5/SMOG Modeling System Configuration



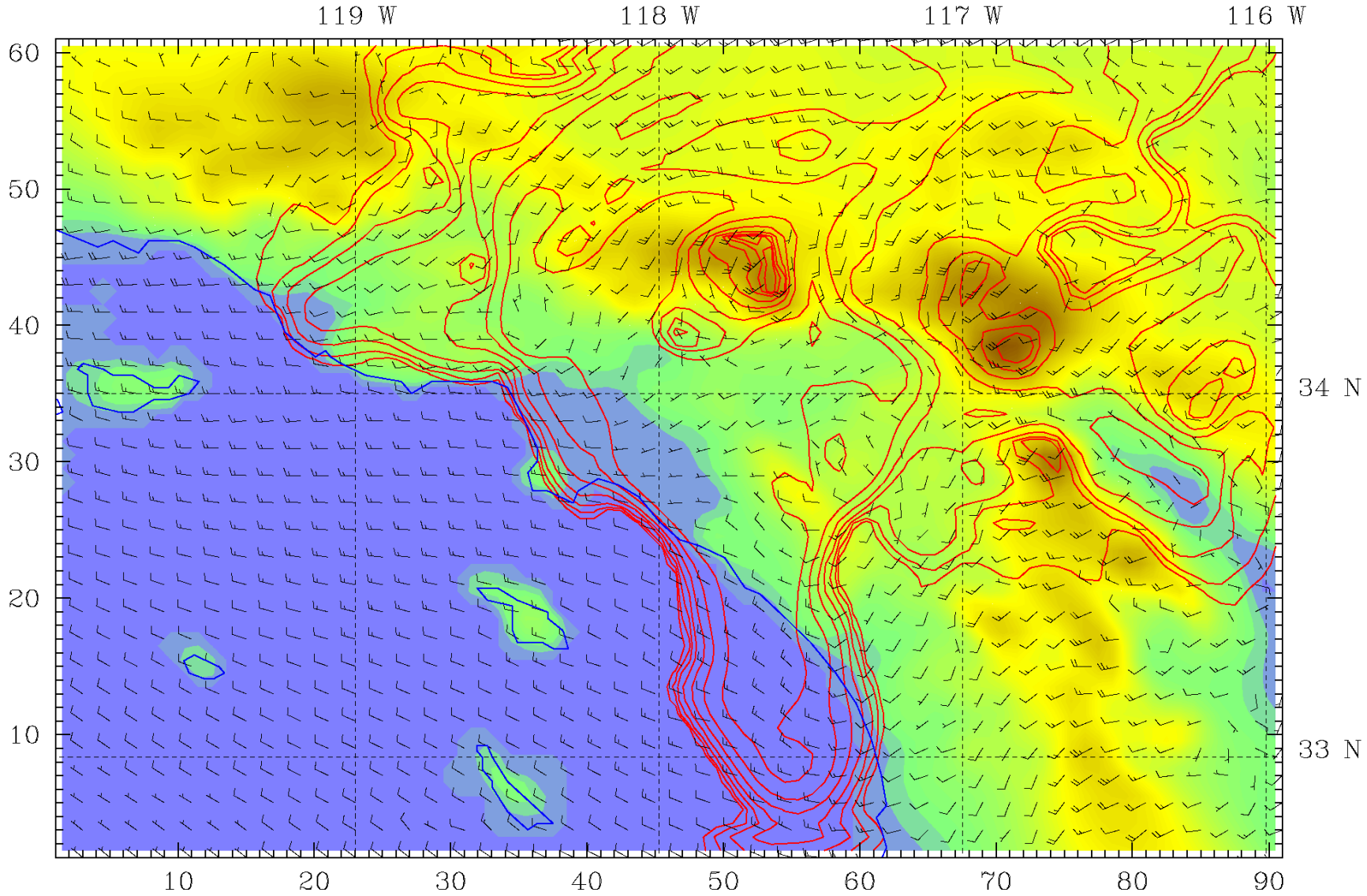

130 W
120 W
110 W
100 W
50 N
40 N
30 N
D01
D02
D03

Westerly Condition Case

On January 27 – 29, 2002, the predominant winds over U.S. west cost were the westerly flow. Sea/land breezes were developed in the LA basin. CO was transported offshore at night, and then onshore and inland during the day time. Near surface, CO was transported to Nevada within 24 hours, and to Colorado in 48 hours. In the middle troposphere, CO was transported to the east U.S. within the westerly jet.

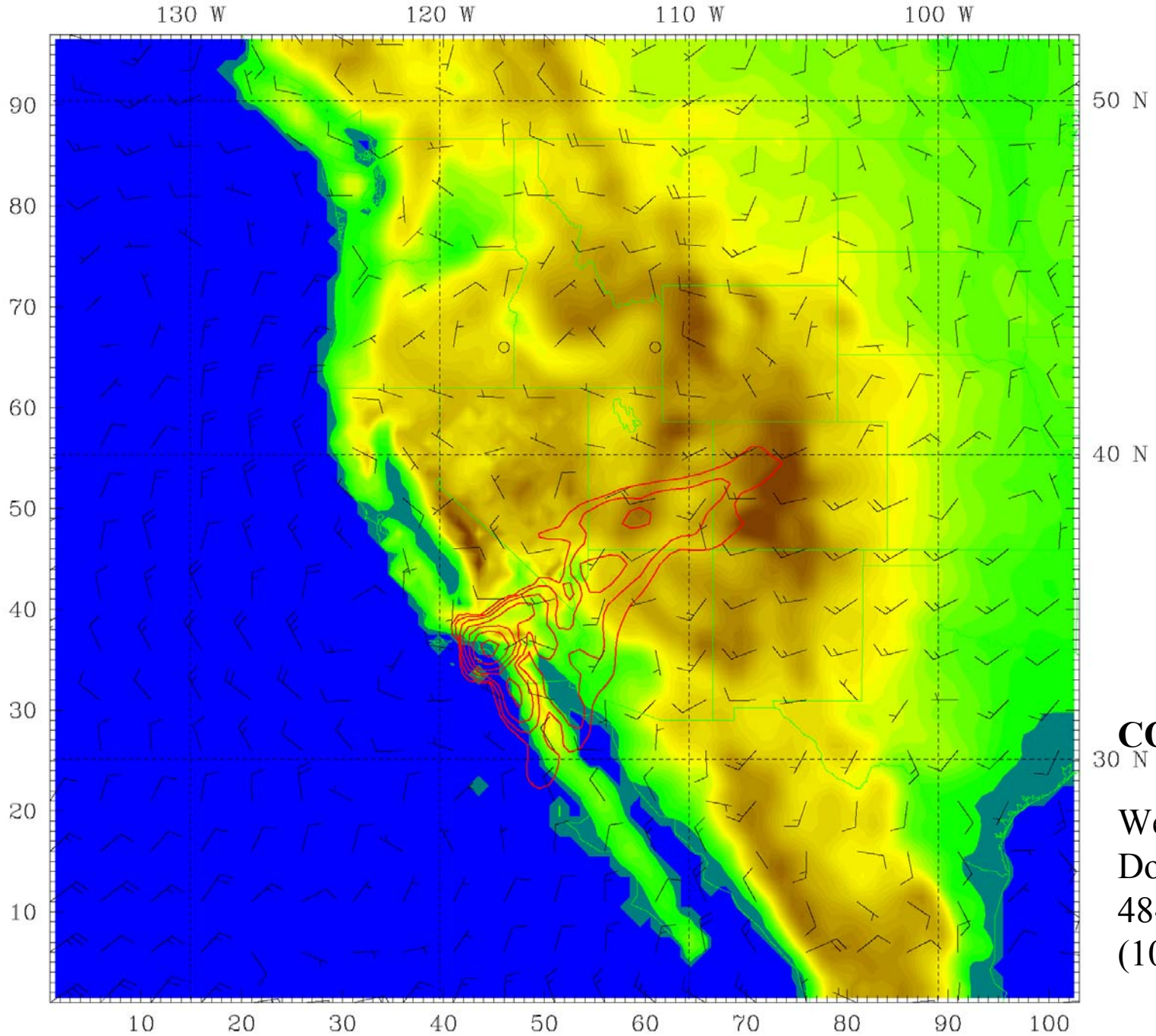
Santa Ana Condition Case

On February 22, 2002, the Southern California was in Santa Ana conditions, when strong downslope northeasterly winds over most of the area. CO from the LA basin was transported offshore. Over the coastal ocean surface, CO moved north and then inland, enhancing pollutant concentration in the central and northern California.



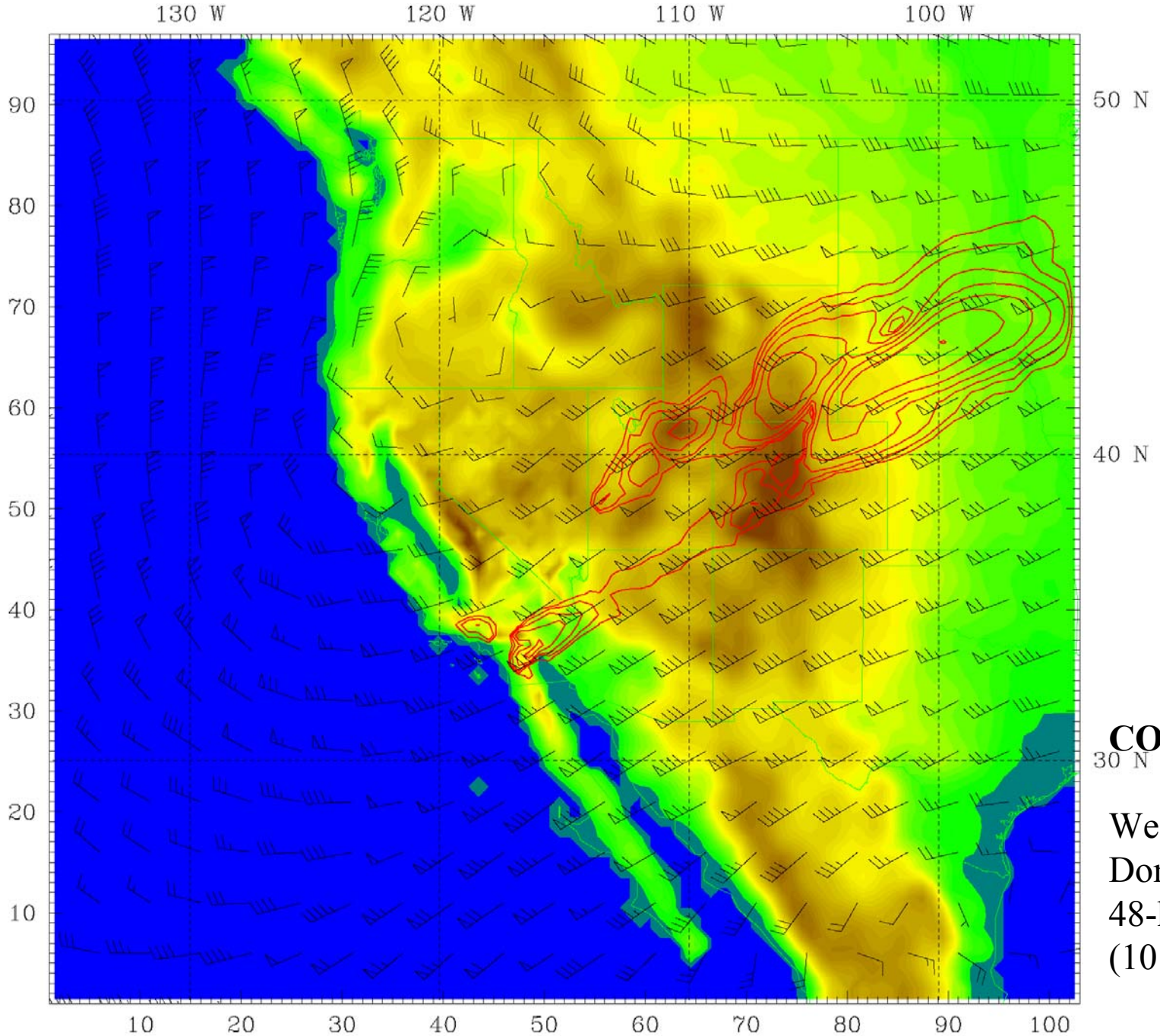
Distribution of CO in the Los Angeles area during westerly wind conditions

Domain 3, 18-h Prediction (4 pm , 1/28/02)



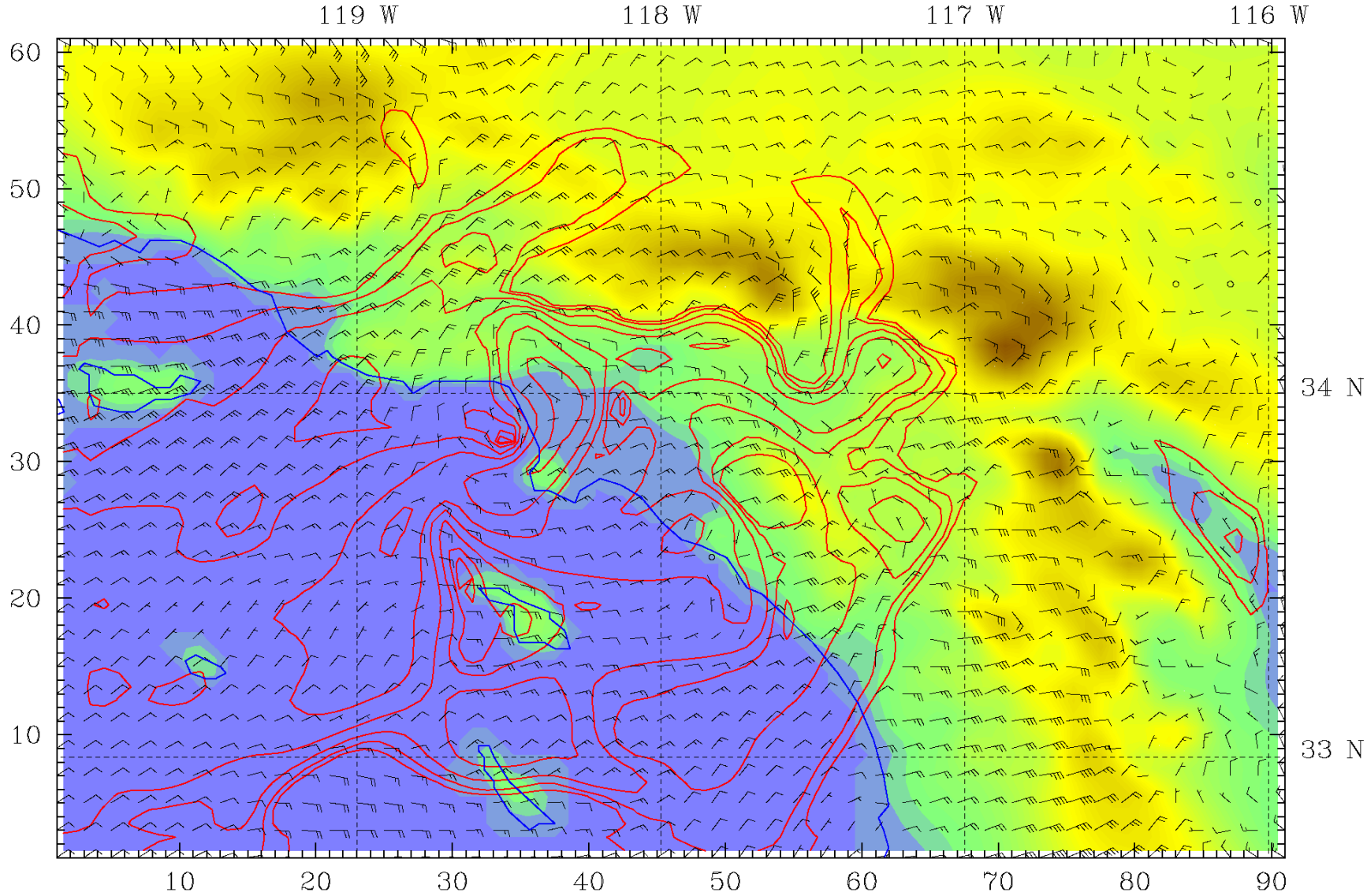
CO Distribution

Westerly Case
Domain 1, Surface
48-h Prediction
(10 pm , 1/29/02)



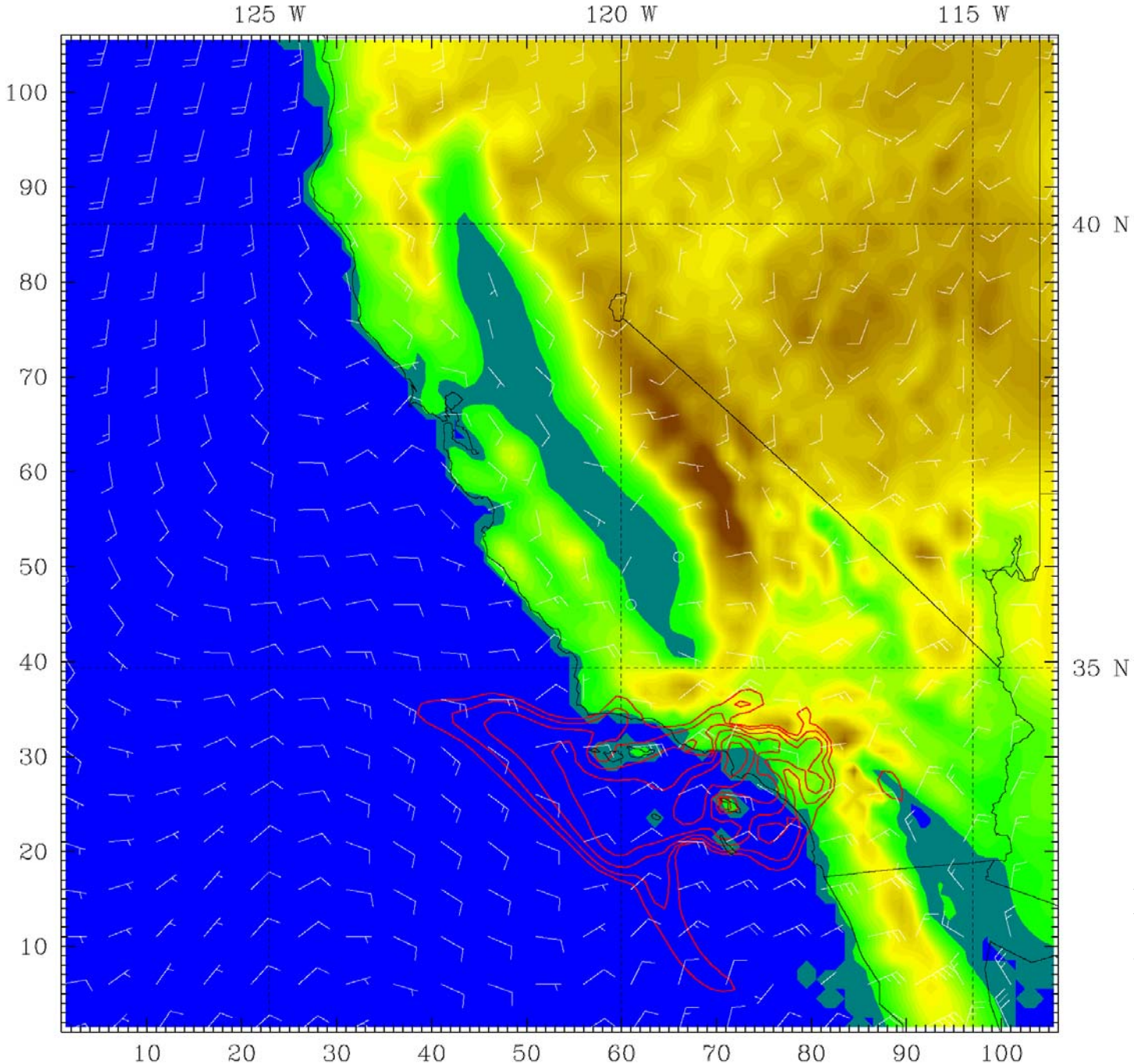
CO Distribution

Westerly Case
Domain 1, 500mb
48-h Prediction
(10 pm , 1/29/02)



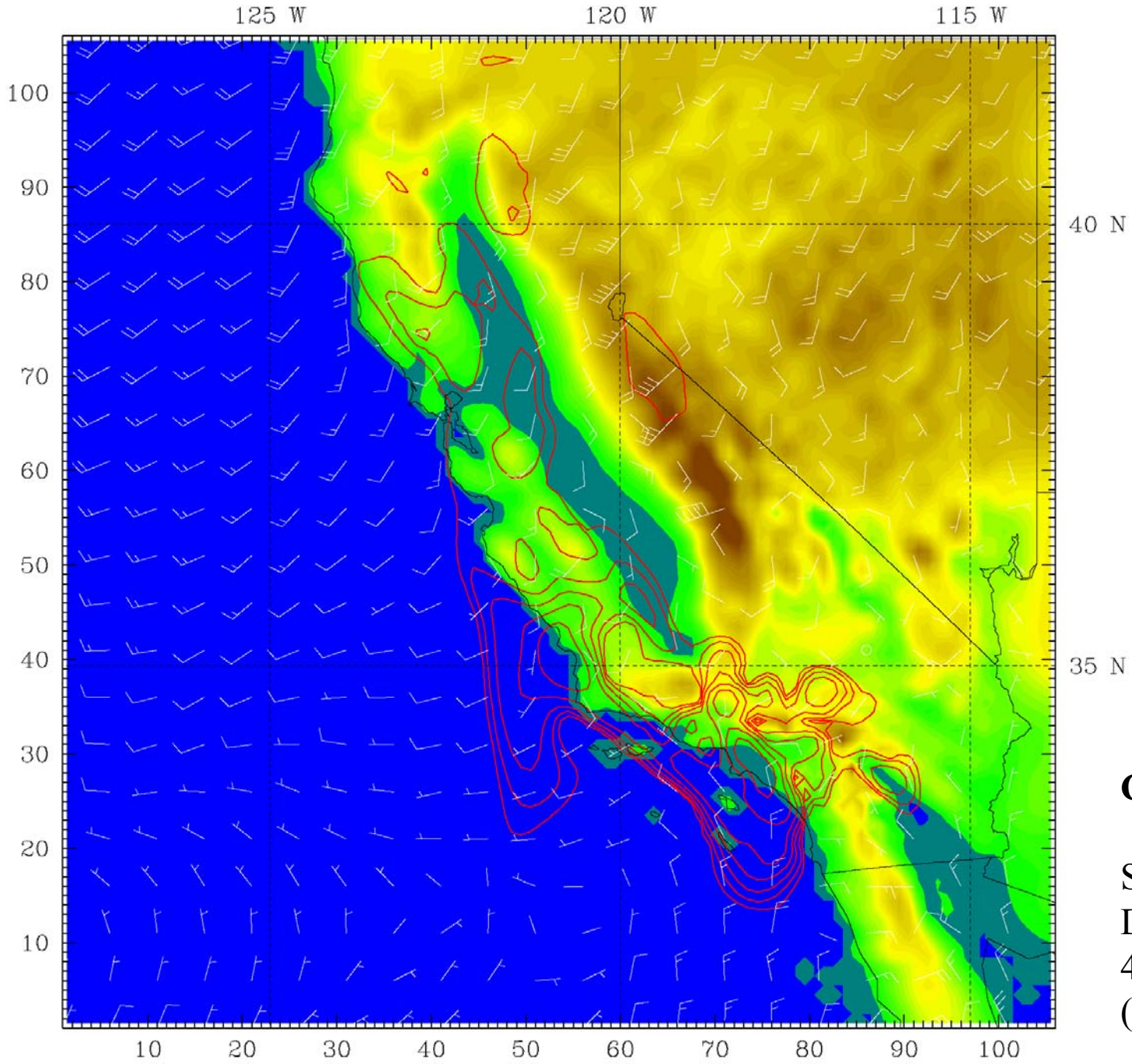
Distribution of CO from LA to the coastal ocean surface during Santa Ana conditions

Domain 3, 24-h Prediction (10 pm , 2/22/02)



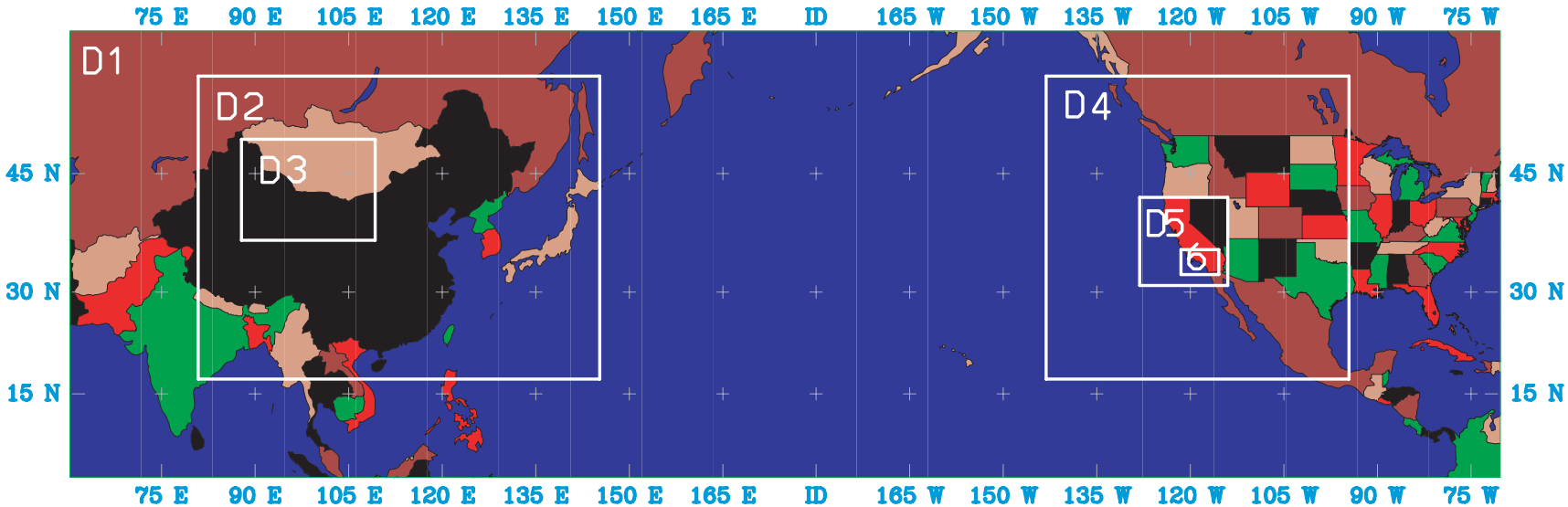
CO Distribution

Santa Ana Case
Domain 2, Surface
24-h Prediction
(10 pm , 2/22/02)

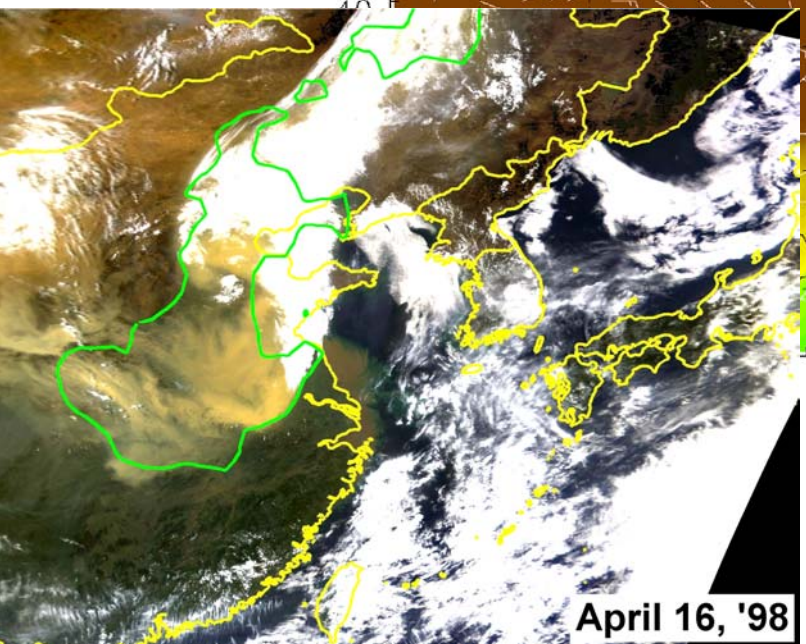


CO Distribution

Santa Ana Case
Domain 2, Surface
48-h Prediction
(10 pm , 2/23/02)


75 E
90 E
105 E
120 E
135 E
150 E
165 E
ID
165 W
150 W
135 W
120 W
105 W
90 W
75 W
45 N
30 N
15 N
D1
D2
D3
D4
D5
6

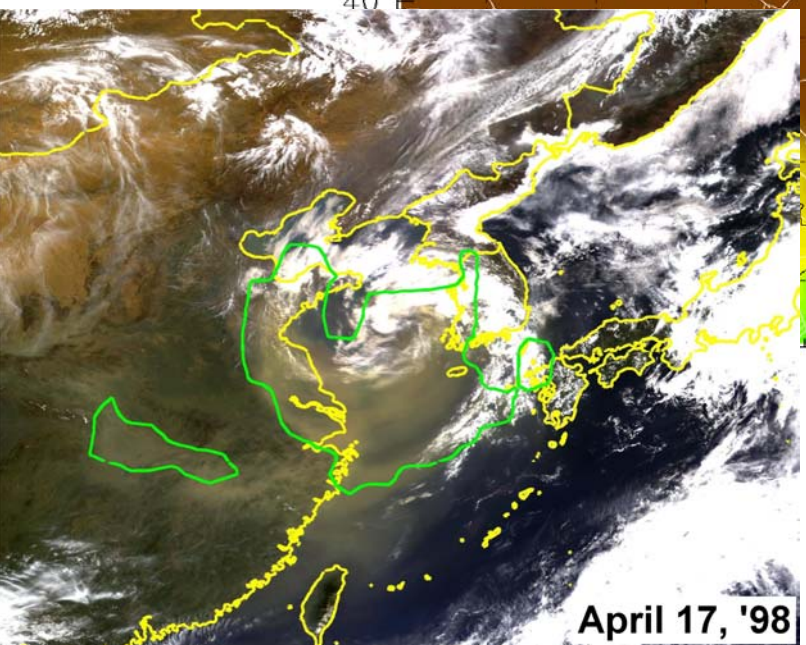
April 15
Dust Event



Model: 00Z April 16, 1998

SeaWiFS satellite data (Husar et al., 2001)

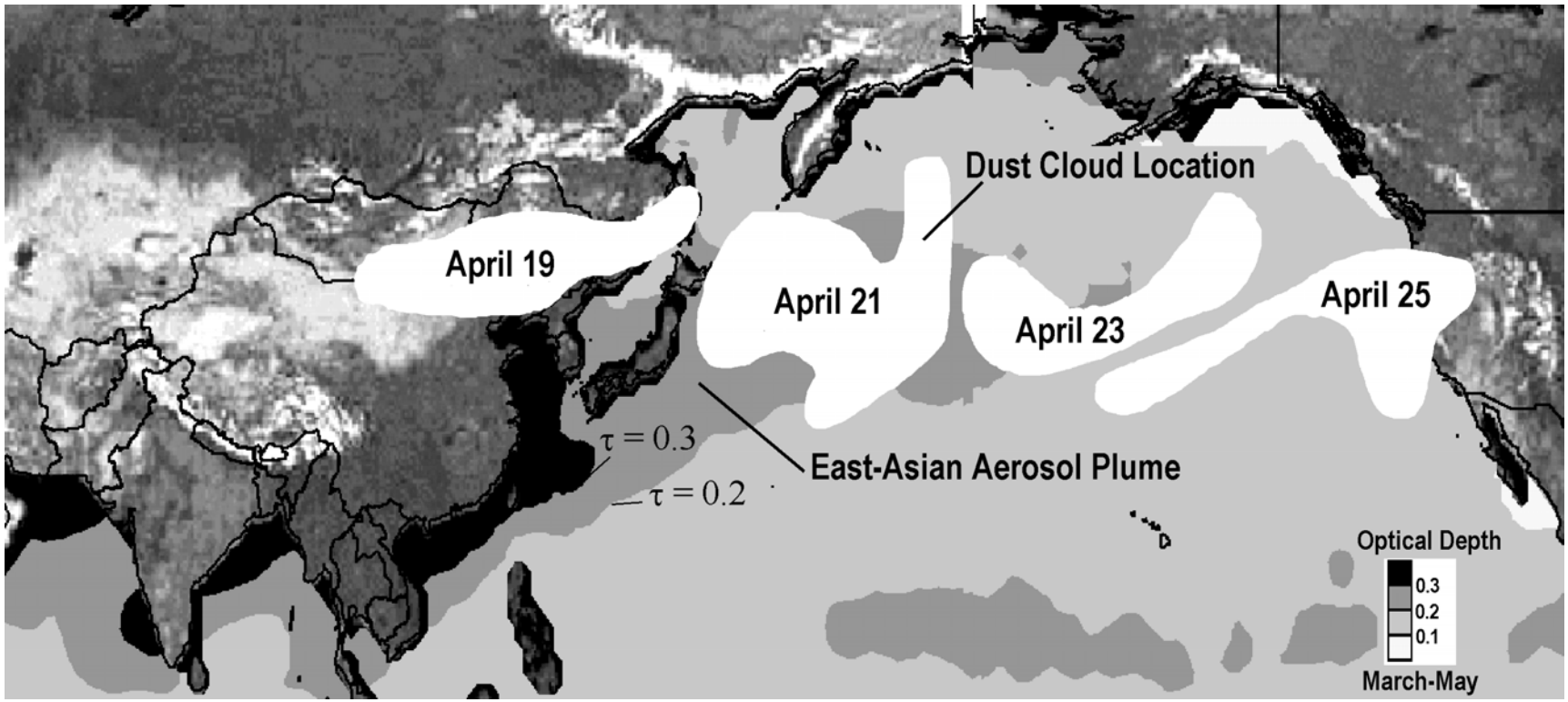
April 15
Dust Event



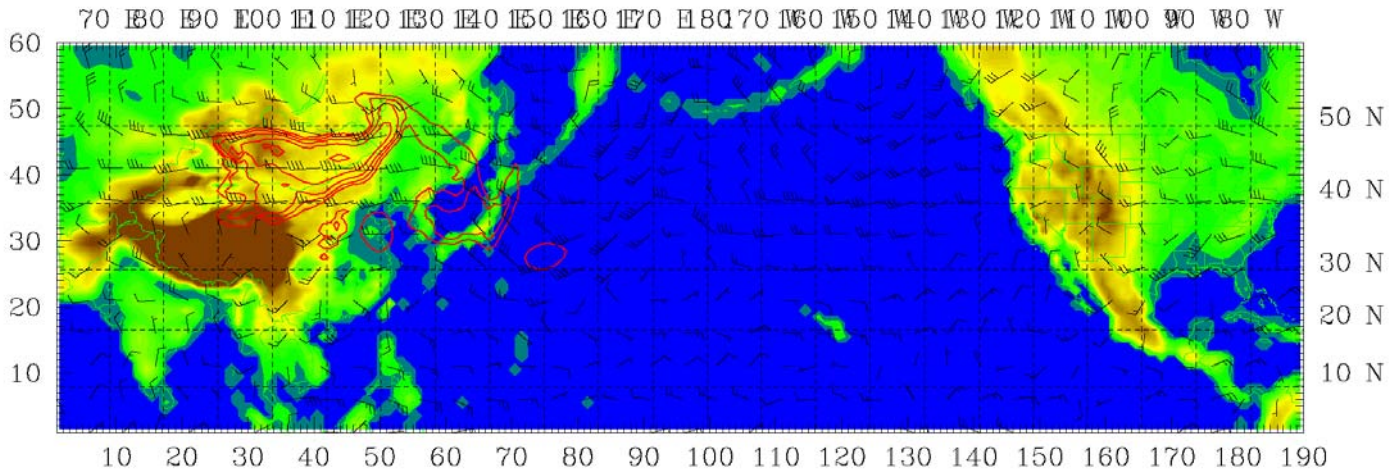
Model: 00Z April 17, 1998

SeaWiFS satellite data (Husar et al., 2001)

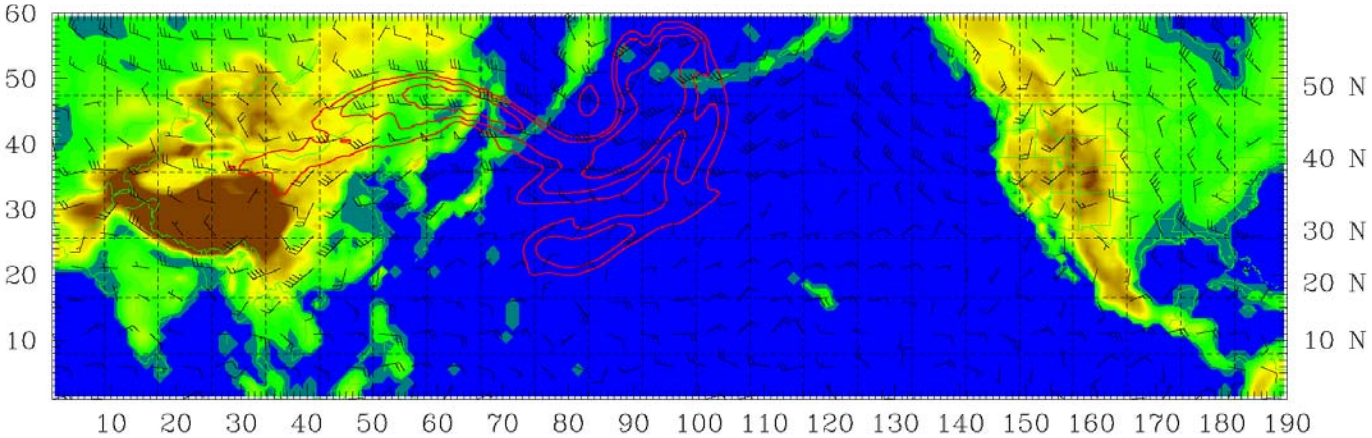
April 19, 1998, Asia Dust Event



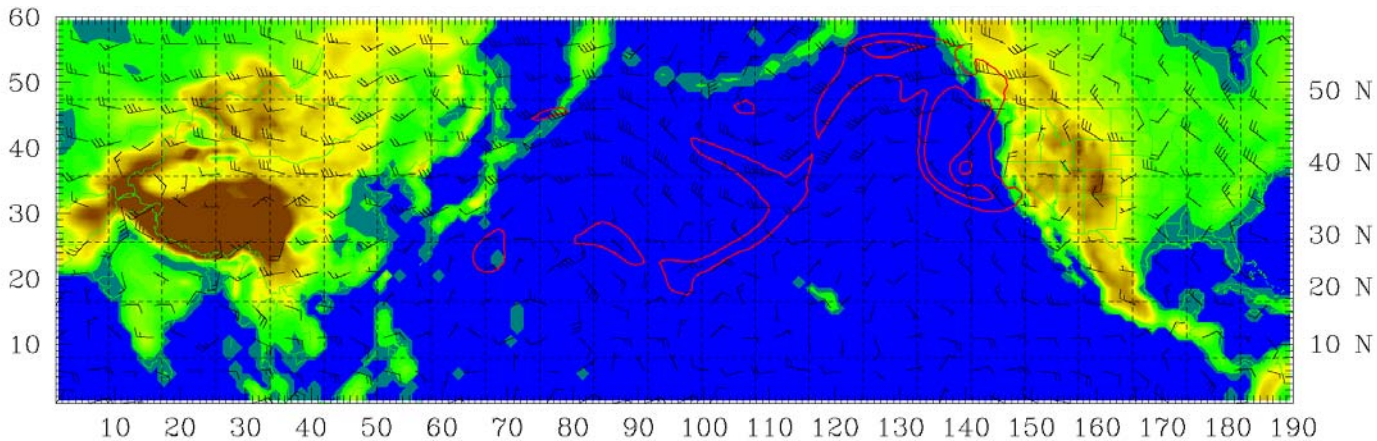
The approximate dust pattern derived from SeaWiFS images (Husar et al., 2001)



12Z April 19, 1998



12Z April 22, 1998



12Z April 25, 1998

Conclusion and Future work

- We have carried out a series of detailed regional aerosol simulations in Southern California to test the ability of the model to treat processes, including dispersion and removal. Detailed comparisons has been made between model predictions and field measurements for a wide range of parameters and substances. In general, calculations compare favorably with observations.
- The deposition of species on coarse particles mainly impacts urban source regions and adjacent areas. Trace components on fine particles are deposited over regional scales through long-range transport. The results suggest that routine air quality measurements of PM10 and PM2.5 are inadequate to characterize local to urban scale trace metal deposition rates.
- Most of emissions in the LA basin are found to disperse outside of the region. They can be contained within the boundary layer and move as a series of plumes first through mountain passes and then slowly across the arid southwestern United States; or be injected into the free troposphere and carried by jets and fronts over continental to global scales.
- Over Eastern Asia/Western Pacific, the model has successfully simulated the dust dispersion from the April 1998 dust storm. The simulated dust patterns are consistent with satellite observations.
- We will collect aerosol sources data to drive the coupled MM5/SMOG model, and compare the predictions against available field observations in the region. These comparisons will serve to define the overall fidelity of the model and will allow a rough calibration of the sources. After that we will perform fully coupled 3-D simulations of aerosol behavior in the areas of interest.